

What is the difference between X-Rays, CT Scans, and MRIs?



X-Rays are a form of electromagnetic radiation, like light. They are less energetic than gamma rays, and more energetic than ultraviolet light. Because they pass easily through soft tissue, like organs and muscles, but not so easily through hard tissue like bones and teeth, we are most familiar with them being used to look at skeletal structures. Sometimes a person ingests or has injected an X-ray opaque fluid that will fill a space of interest for X-ray imaging. This is called an **angiogram**. A **nuclear scan** uses an injected gamma ray emitting substance that accumulates in the organ of interest and a special camera records the gamma rays.

A **CT Scan** is usually a series of X-rays taken from different directions that are then assembled into a three dimensional model of the subject in a computer. CT stands for computed tomography, and tomography means a picture of a slice. Where an X-ray may show edges of soft tissues all stacked on top of each other, the computer in a CT scan can figure out how those edges relate to each other in depth, and so the image has much more soft tissue usability.

Another kind of CT scan uses positrons. I have to mention this because positrons are antimatter electrons (Yes, antimatter does exist and it is useful!) In **Positron Emission Tomography (PET)** a positron emitting radionuclide (radioactive material) is attached to a metabolically useful molecule. This is introduced to the tissue, and as emitted positrons decompose they emit gamma rays which can be traced by the machine and computer back to their points of origin, and an image is formed. It is used to analyze the functions of a tissue.

In **Magnetic Resonance Imaging (MRI)**, specific frequency radio waves are used to jostle the nuclei of hydrogen atoms, which are plentiful in both water and in fats. Powerful magnets detect the hydrogen response and map the locations of the tissues where the hydrogen resides. It does not use ionizing radiation, the radio waves are longer and lower energy than visible light or microwaves. Most MRI machines are huge and very expensive. There is a group at Los Alamos building an ultra-sensitive low power MRI that will fit in a pick-up truck. They hope it will find applications in battlefield medicine and in third world countries that can't afford conventional MRI equipment. It is an exciting project.